(12) UK Patent Application (19) GB (11) 2 400 612 (13) A

(43) Date of A Publication 20.10.2004

(21) Application No: 0308730.1

(22) Date of Filing: 15.04.2003

(71) Applicant(s):
H-Empower Corporation
(Incorporated in the Bahamas)
3rd Floor Trade Winds Building,
Bay Street, Nassau, Bahamas, Bahamas

(72) Inventor(s):
John McNeil

(74) Agent and/or Address for Service:
Frank B Dehn & Co.
179 Queen Victoria Street, LONDON,
EC4V 4EL, United Kingdom

(51) INT CL^7:
C25B 1/02 1/04

(52) UK CL (Edition W):
C7B BCAX BDBB B146 B758 B759

(56) Documents Cited:
GB 2263734 A
WO 2002/084839 A2
US 4184084 A
WO 2003/083174 A2
WO 2001/036817 A1
JP 530021088 A
& WPI Accession no 78-27533A

(58) Field of Search:
UK CL (Edition W) C7B
INT CL^7 C25B
Other: Online: WPI, EPODOC, JAPIO

(54) Abstract Title: **Supply of homopolar electricity for water electrolysis**

(57) The current required to effect the electrolysis of water is produced by a homopolar generator 4. The homopolar generator 4 may be wind powered and produces low voltage, high direct current which may be supplied to low pressure, low temperature water in electrolysis units. The homopolar generator 4 preferably comprises means 7 to produce a toroidal magnetic field 12, means to position a conductive metal disc 5 in the magnetic field 12 and means 16,18,19 to collect the electric current generated in the disc 5 when it is rotated in the magnetic field 12.

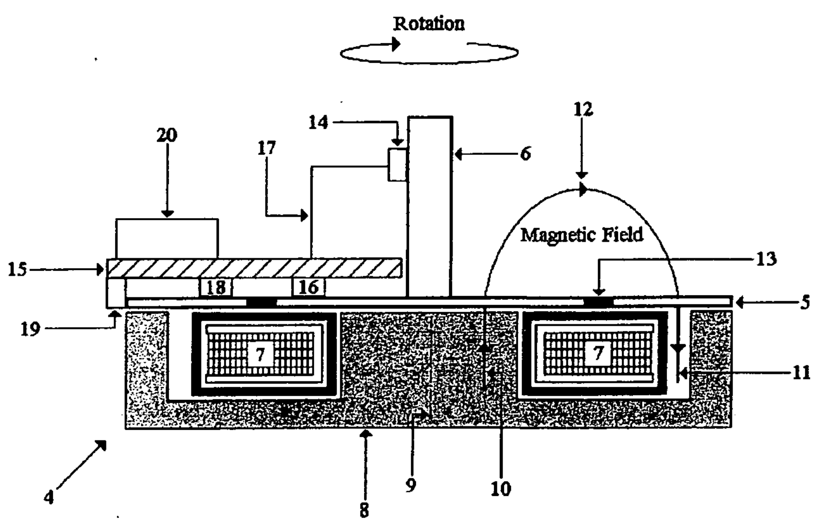


Figure 2

GB 2 400 612 A

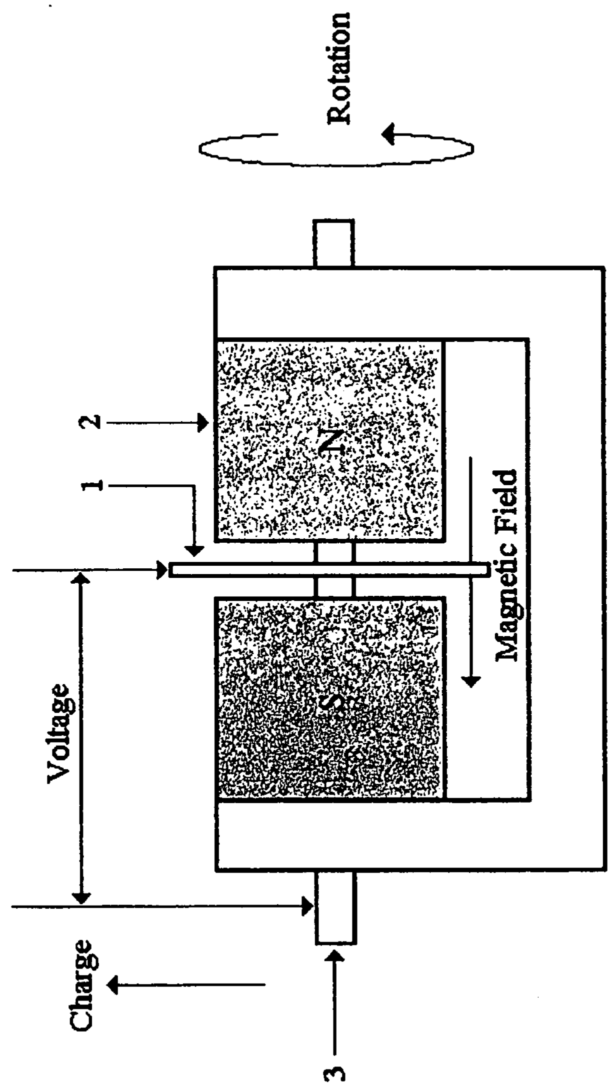
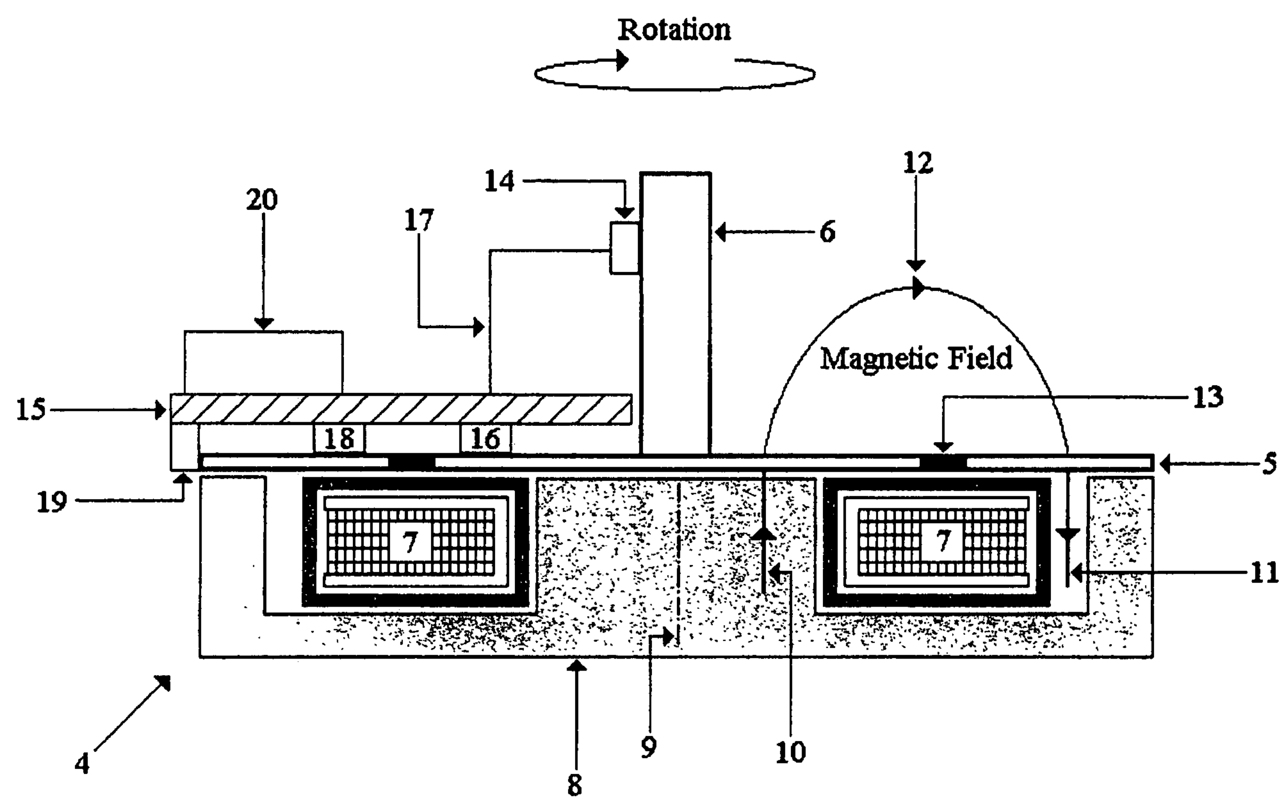


Figure 1



Rotation
Magnetic Field
4
5
6
7
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Figure 2

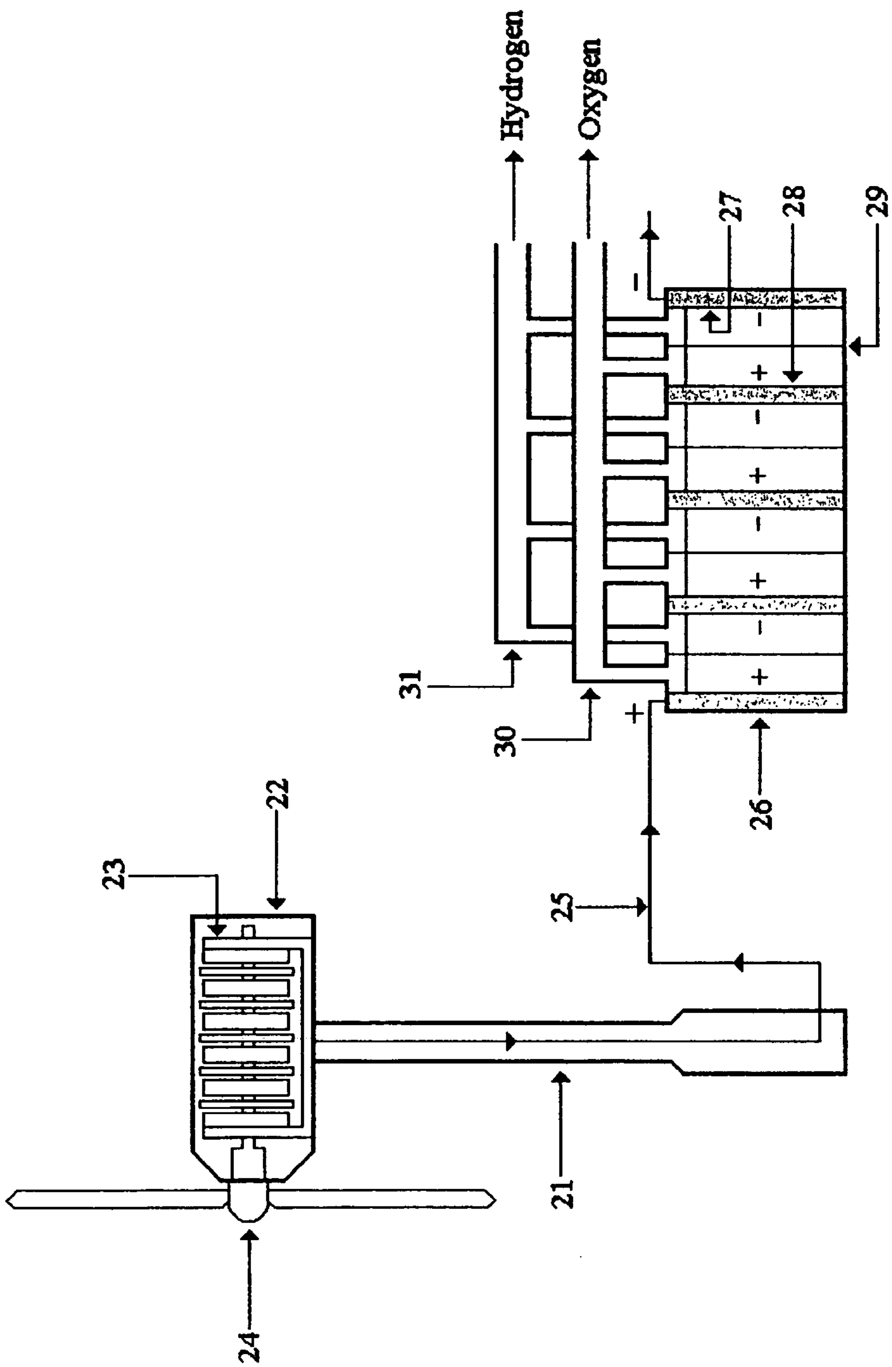


Figure 3

2400612

80582 207

Supply of Electricity for Water Electrolysis

The present invention relates to a method of using a preferably wind powered homopolar generator to supply the direct electric current required to electrolyse water into hydrogen and oxygen.

When water is subjected to electrolysis, the water decomposes into hydrogen and oxygen, and when hydrogen is burned it recombines with oxygen to form water. Hydrogen is therefore a unique potential source of renewable energy because, in theory, this cycle of converting water to hydrogen and then combusting the hydrogen to produce more water could be repeated endlessly. The following reactions illustrate the water to hydrogen to water cycle·

Electrolysis of water: $2H_2O = 2H_2 + O_2$

Combustion of hydrogen: $2H_2 + O_2 = 2H_2O$

In contrast to fossil fuels, which produce carbon dioxide during combustion, when hydrogen is burned water is the only product of combustion. Carbon dioxide is a greenhouse gas and it is now widely accepted that the combustion of fossil fuels is contributing towards global warming. Because hydrogen is such an exceptionally clean burning fuel, there is increasing interest in developing hydrogen as a renewable energy resource, and in particular for transport applications where environmental pollution from the combustion of conventional petroleum fuels is now causing worldwide concern.

Hydrogen can be produced by chemical reactions as well as by electrolysis. For example, reacting a hydrocarbon, such as methane, with steam, in the presence of a nickel catalyst, produces hydrogen and carbon monoxide, and reacting carbon, in the form of coal or coke, with water produces hydrogen and carbon dioxide. However, greenhouse gases as well as hydrogen are produced by these chemical reactions, and because the reactants, methane and coal, are fossil based materials neither method of manufacture is sustainable in the long term.

Even though methane and coal are fossil fuels, and they therefore produce carbon dioxide greenhouse gas when burned, it would still be much more cost effective at the present time to directly burn methane and coal to generate electricity, rather than converting these fossil based materials into hydrogen for use as a clean burning fuel.

In contrast to using chemical methods to produce hydrogen, the electrolysis of water is a clean, pollution free process. Combining the electrolysis of water and the combustion of hydrogen therefore provides an opportunity to develop a unique and sustainable energy cycle.

Water electrolysis is a well known process, which can be briefly described as follows. When two oppositely charged electrodes are inserted into water and a current is passed between them, electrons are transferred from the anode to the cathode. As the electric current passes through the water, the chemical bond between hydrogen and oxygen breaks down to produce two positively charged hydrogen ions and one negatively charged oxygen ion. The negative oxygen ions then migrate to the positive electrode (the anode) and the positive hydrogen ions are attracted to the negative electrode (the cathode).

The smallest amount of energy needed to electrolyse one mole of water into hydrogen and oxygen is 65.3 Wh at 25°C and when hydrogen and oxygen are recombined by combustion into water 79.3 Wh of energy is released. 14 Wh more energy is therefore released during the combustion of hydrogen than is needed to split water into hydrogen and oxygen.

The electrical resistance of pure water is high at 100 ohm/cm, and to encourage electrolysis the electrical resistance is usually lowered by the addition of heat; pressure; a salt to the water; an acid to the water; an alkali to the water; or a suitable combination of such variables. By way of example, a low pressure commercial water electrolyser may well typically operate under normal atmospheric pressure at a temperature of about 70°C and use an electrolyte consisting of 25% to 30% potassium hydroxide solution.

An electrolysis cell primarily consists of a pair of electrodes immersed into a container of electrolyte, and a water electrolysis unit is composed of a number of electrolysis cells combined together, either in series and/or in parallel, in order to provide a greater output of hydrogen and oxygen.

However, the electrolysis of water is an unusual electrical process in so far as it requires a low voltage but very high direct electric current. The voltage required for water electrolysis is about 1 to 2 volts, and depending on the efficiency of the electrolysis system the energy input needed to electrolyse water is approximately equivalent to 4 kWh/m^3 of hydrogen produced

Although the voltage required to effect water electrolysis remains fairly constant, water will electrolyse under varying levels of current. For example, commercially available electrolysis units operate with currents varying from about 1500 amps/m^2 up to 5000 amps/m^2 or more. The volume of hydrogen produced by electrolysis is, however, related to the current, i.e. the higher the current, the more efficient the electrolysis process tends to be.

Although water itself is cheap, abundant and readily available, the electrolysis process itself is energy intensive and also requires a specific supply of low voltage, high direct current.

When conventional grid electricity is used to power a water electrolysis process, the normal high voltage alternating current has to be converted into low voltage direct current, i.e. from AC to DC electricity Such radical current commutation requires expensive transformers and rectifiers, and significant losses can also occur during the current conversion process.

Using normal grid electricity as the current supply for the electrolysis process also negates the reasons for producing hydrogen in the first place, namely that hydrogen is a clean, renewable source of energy. At the present time, large-scale power generation for national grid supplies is predominantly based on burning fossil fuels, such as coal, natural gas and oil, and combusting these fossil fuels to generate electricity will already have had a detrimental impact on the environment.

The present invention seeks to provide an efficient, clean and sustainable method of supplying the specific electric current that is required to electrolyse water into hydrogen and oxygen.

From a first broad aspect therefore the invention provides a method of supplying the low voltage but high direct current needed to operate a water electrolysis unit, by using a homopolar generator to produce the specific electric current required.

The principles of homopolar generation were originally established by Faraday who found that when a conductive disc was rotated through a magnetic field, a voltage was generated between the centre of the disc and the outer rim of the disc. Homopolar machines produce a unidirectional electromotive force, and homopolar generators are unique in that they produce low voltage but high direct current. Because the current produced is low voltage, homopolar generation is also a relatively safe method of generating and transmitting electricity.

Figure 1 is a schematic cross-section illustration of a simple homopolar generator, based on the principles first described by Faraday.

In Figure 1, a shaft 3 runs through the centre of both poles of a magnet 2, and in a manner whereby shaft 3 can freely rotate within the magnet 2. A metal disc 1 is fixed to shaft 3 and is spatially arranged so that the metal disc 1 is centrally located between the north and south poles of the magnet 2. Rotation of shaft 3, by the application of an external rotating force, correspondingly rotates the metal disc 1 between the poles of the magnet 2, so that the disc intersects the magnetic field produced by the magnet.

Rotation of disc 1 in the magnetic field generates a voltage between the centre of the disc and the rim of the disc An electric charge, which can be collected by electrical contact brushes placed at the rim and at the centre of the disc, is produced in disc 1.

The efficiency of a homopolar generator is greatly improved if an annular magnetic field, whose axis passes through the centre of the drive shaft, is used in the system When an annular magnetic field is used, the electromotive force developed in any ring is constant so that all current paths in the disc are radially orientated.

Such machines tend to generate very low electromotive forces, even at high speeds, and homopolar generators are therefore ideally suited for applications where low voltage, high current is required, as is the case with the electrolysis of water.

Improvements in the performance of homopolar generators have tended to concentrate on utilising as much of the available magnetic field as possible. Particular emphasis has been placed on the shape and position of the magnets used in homopolar machines and also on the relative spatial arrangement of the magnets and the conductive disc.

Another refinement to homopolar machines has involved the use of superconducting electromagnetic coils. Superconducting coils are able to produce high magnetic fields, which is beneficial for efficient homopolar machine operation. However, to perform effectively most superconducting materials have to be used at extremely low temperatures, i.e. temperatures at or close to cryogenic temperatures, and the need to maintain such low temperature operating conditions does have an affect on the capital and operating costs of the homopolar machine.

The magnetic field produced by an annular magnet or an annular electromagnetic coil has an axis of rotational symmetry and the field is toroidal in character. Lines of magnetic flux emanate from the centre of the magnet or coil and initially flow outwards in a forward direction. The magnetic flux then moves in a circular toroidal manner until the magnetic flux eventually returns back to the rear of the magnet or coil.

Homopolar machines were originally designed with the conductive disc positioned so that the disc only intersected the magnetic field travelling in a forward direction, as illustrated in the basic homopolar machine shown in Figure 1. The performance of a homopolar generator can be improved if both the forward and the return magnetic fields produced by a magnet or a coil are utilised to generate current in the disc.

Figure 2 is a schematic cross-sectional illustration of a typical homopolar generator that has been designed to enable the conductive disc inside the homopolar machine to intersect both the forward and the return magnetic fields produced by an electromagnetic coil

In Figure 2, the metal conductive disc 5, which is attached to a drive shaft 6, and the annular electromagnetic coil 7 are together referred to as the homopolar generator 4

The annular electromagnetic coil 7 is composed of many turns of either conducting material or more preferably superconducting material. When a current passes through coil 7, a toroidal magnetic field 12, comprising a forward field 10 and a return field 11, is generated about an axis of rotational symmetry 9.

For ease of illustration, only one magnetic line of flux 12 with a forward field 10 and a return field 11 is shown in Figure 2. Diagrammatic lines of flux are a pictorial device used to illustrate a magnetic field, and a true representation of the magnetic field generated by coil 7 would require an infinite number of lines of flux completely surrounding the annular coil 7.

A thin and substantially flat conductive metal disc 5 is connected centrally to a shaft 6 in a manner whereby rotation of shaft 6, by an external rotary motive force, would also rotate disc 5 about a central axis that is perpendicular to the disc whilst being simultaneously coincident with the central axis 9 of the magnetic field.

The metal disc 5 and the annular coil 7 are spatially arranged so that the forward magnetic field 10 passes through the central portion of disc 5, whilst the return magnetic field 11 passes through the outer portion of disc 5 The central portion of disc 5, which is subjected to the forward magnetic field 10, is separated from the outer portion of disc 5, which is subjected to the return magnetic field 11, by a ring of insulating material 13 that runs radially around the disc at a fixed distance from the centre of the disc. The disc 5 is also positioned so that the bottom surface of the disc is in close proximity to the annular coil 7.

When disc 5 is rotated through the toroidal magnetic field, the currents generated in the inner and outer portions of the disc 5, which are subjected to the forward and reverse magnetic fields respectively and are separated by the insulating ring 13, flow in opposite directions in the two portions of the disc.

In this particular embodiment of a homopolar generator, the annular coil 7 is surrounded by a core 8 of highly permeable magnetic material such as soft iron. The iron core 8 further concentrates the return magnetic field 11 towards coil 7, so that more of the return field passes through the outer region of disc 5, thus allowing disc 5 to utilise more of the magnetic field produced by the annular coil 7.

A slide arm mechanism 15 is fixed in position above the top surface of the conductive disc 5, and in a manner whereby the slide arm 15 extends from the centre to the outside of the disc, i e. the inner end of slide arm 15 is in close proximity to drive shaft 6, whilst the outer end of slide arm 15 extends over the outer rim of disc 5.

Electrical current contact brushes 16, 18 and 19 are located on the underside of slide arm 15. Brush 16 collects the current produced on the inner portion of disc 5 An interconnecting slide arrangement between arm 15 and brush 16 allows the position of brush 16, relative to the top surface of disc 5, to be adjusted by sliding brush 13 along arm 15 until the brush is at the required position on the inner portion of disc 5.

Brush 18 collects the current produced on the outer portion of disc 5. An interconnecting slide arrangement between arm 15 and brush 18 allows the position of brush 18, relative to the top surface of disc 5, to be adjusted by sliding brush 18 along arm 15 until the brush is at the required position on the outer portion of disc 5.

This arrangement allows fine adjustment of the contact brushes 16 and 18, until the brushes are at the point of maximum current on the inner and outer portions respectively of the conductive disc 5. The contact brushes 16 and 18 can then be locked in place on the slide arm 15 by using fixings mounted on the brushes and the slide arm respectively.

It is essential that brushes 16 and 18 make good contact with the top surface of disc 5, in order to allow efficient collection of the electric current generated by the homopolar machine. To help provide good conducting properties between the contact brushes 16 and 18 and disc 5, a liquid metal contact material could be used on the surface of the disc, and such liquid metal conducting materials are described in US Patent Number 5281364 by the applicant.

Another current contact brush 14 makes contact with the drive shaft 6, and a further contact brush 19 mounted under the outer end of slide arm 15 makes contact with the outer rim of disc 5. Again it is essential that good electrical contact is made by brushes 14 and 19 with the drive shaft and the outer rim of the disc respectively.

Rotation of shaft 6 by an external motive force rotates disc 5 through the toroidal magnetic field produced by the annular coil 7. This in turn generates electric currents in the inner and outer portions of disc 5, which are collected by contact brushes 16 and 18. Brushes 16 and 18 are easily adjusted on slide arm 15 until the position of optimum current is reached on the inner and outer portions of disc 5 respectively.

Brush 16 and brush 14 are connected to an electrical circuit 17, and brush 18 and brush 19 are connected to an electrical circuit 20. The two circuits 17 and 20 are connected together, either in series or in parallel, before the combined current is finally transmitted from the homopolar generator to the water electrolysis unit. Means to measure and control the current can be included in the electric circuit that takes the current from the homopolar generator to the water electrolysis unit.

Homopolar generators are also compact machines and, for example, they can easily be connected together in multiple combinations, either in series and/or in parallel, in order to produce sufficient current to be able to run multiple combinations of electrolysis units, which would also be connected together either in series and/or in parallel.

Developments in the design of homopolar machines, superconducting materials and current collection systems have resulted in homopolar generators becoming much more efficient. For example, it is not unknown for homopolar generators to have an efficiency of over 99%.

A homopolar generator is therefore an effective method of directly supplying the low voltage, high current needed to operate a water electrolysis unit. Apart from relatively simple means to measure and control the current, no other sophisticated commutation equipment, such as expensive and inefficient transformers and rectifiers, would be required to change the current before it was supplied to the electrolysis unit.

The motive force used to drive the homopolar generator does, however, require careful consideration. Because hydrogen is a clean burning, renewable fuel, the power source used to drive the homopolar generator, and hence produce the current for the electrolysis unit, should also preferably be renewable and non-polluting by nature.

Wind, for example, is such a renewable energy resource Although capital costs would be involved in the design and construction of a wind powered homopolar generating system, the wind itself is a free and renewable source of energy. Using wind to power a homopolar generator would not only provide cost effective electricity for the water electrolysis process, but also the electricity would be to the required low voltage high current specification without the need for further transformation..

From a further aspect therefore, the invention provides a method of supplying low voltage, high current electricity to a water electrolysis unit, by using wind as the renewable source of energy to power a homopolar generator.

Conventional wind powered electricity generators have tended to provoke hostile public reaction, mainly because large numbers of wind generators are usually located close together in wind farms, and such wind farms tend to be obtrusive in the landscape. However, a single wind generator is far less obtrusive, and a single homopolar wind machine, or even a small number of such wind machines, is much more likely to gain acceptance by the general public and local planning authorities than large wind farms.

A major disadvantage of wind power is that it is intermittent by nature, and on calm days there would be little or no energy available for power generation. The unreliable nature of intermittent energy resources can also cause difficulties to national grid electricity networks, as these tend to rely on predictable electricity supplies.

An advantage of the proposed system is that the current produced by the homopolar generator would be used for water electrolysis only and none of the electricity would be destined for grid supplies. A further major benefit of the proposed system is that the eventual products of the water electrolysis process, i.e. hydrogen and oxygen, can be packaged and stored for later use. The proposed process therefore provides a means of converting intermittent wind power into a more reliable form of renewable energy, i.e. hydrogen, which is packaged and ready for use as and when required.

In theory, other natural renewable energy resources, such as hydro and tidal energy, could also be used to drive a homopolar generator. However, most hydro and tidal power generating systems are dedicated to the large-scale production of conventional AC electricity destined for the national grid. The energy sources for hydro and tidal power, i.e. reservoirs or estuaries, also tend to be situated in remote or distant locations, and these particular forms of renewable energy are therefore much less flexible than wind power.

Preferred embodiments of the invention will now be described by reference to Figure 3, which is a schematic cross-section illustration of a wind powered homopolar generating system connected to a water electrolysis unit.

In Figure 3, a concrete or steel mast 21 supports a generator housing 22. Because homopolar machines are very compact, the generator housing 22 can contain a multiple combination of homopolar generators 23 connected together either in series and/or in parallel.

By using a multiplicity of homopolar machines, a single wind powered homopolar generating system would be capable of producing sufficient current to run a multiple combination of water electrolysis units.

A rotor blade arrangement 24 is coupled to a common drive shaft in the homopolar generators 23, and in a manner whereby the drive shaft would rotate at a controlled, fixed speed. The drive shaft is attached to conductive discs located inside the homopolar generators 23, and in such a way that the discs intersect the toroidal magnetic fields produced by annular electromagnetic coils also located within the homopolar machines. The electromagnetic coils could be manufactured from either conductive material or superconductive material.

Rotation of the rotor blades 24, by the force of wind, would rotate the drive shaft, which in turn would rotate each conductive disc through its associated toroidal magnetic field within each of the homopolar generators 23. Current generated across the discs would be collected by a suitable arrangement of electrical contact brushes.

The electrical circuits between the electrical contact brushes and between the separate homopolar generators would be connected together either in series and/or in parallel The current taken from the homopolar generators would then be supplied by an electric circuit to the water electrolysis units, and means to measure and control the current would be included in the electrical circuit.

The current from a single homopolar generator would typically have a voltage of about 2 volts and a power density of about 5000 amps/m² or more, whilst the energy consumption of a typical electrolysis unit is about 4 kWh/m³ of hydrogen produced.

By combining a number of homopolar generators together, in series and/or in parallel as appropriate, sufficient current could be produced to be able to operate a similar multiple number of electrolysis units, also connected together either in series and/or in parallel.

The multiple homopolar generation system also provides a means to cater for either variations in demand for current or fluctuations in current due to changes in wind energy. For example, under these circumstances current need only be taken from some of the homopolar generators, rather than all the generators, and the current taken would then be supplied to an appropriate number of water electrolysis units.

For ease of illustration, the water electrolysis unit 26 in Figure 3 consists of only four electrolysis cells. In practice, a typical commercial electrolysis unit could well contain several hundred electrolysis cells and the electrolysis unit could have a total hourly output of over 400m³ of hydrogen and over 200m³ of oxygen.

As already mentioned, a single wind machine is capable of powering a multiplicity of homopolar generators, which in turn could produce enough current to operate an equivalent multiplicity of water electrolysis units. The output from a multi unit electrolysis system could therefore well be over 4000 m³/hour of hydrogen and over 2000 m³/hour of oxygen.

The electrolysis unit illustrated in Figure 3 is a schematic representation of a typical low temperature, low pressure electrolysis system similar, for example, to the type manufactured by Norske Hydro.

Each cell would have a cathode 27, made from say low carbon steel, and an anode 28, made from say nickel plated low carbon steel. The electrolyte in each cell would typically be a 25 % solution of potassium hydroxide, and there would be means to continually replenish the cells with fresh water.

Application of the electric current to the electrolysis cells produces hydrogen at the cathodes of the cells and oxygen at the anodes. In order to keep the hydrogen and oxygen separate from each other within the cells, each cell would include a separator 29 manufactured, for example, from woven asbestos cloth.

Hydrogen from the cathodes of the cells is collected in a discharge tube 31 whilst oxygen from the anodes is collected in a separate discharge tube 30. The hydrogen and oxygen, in discharge tubes 31 and 30 respectively, would be delivered to separate packaging plants, (not illustrated in Figure3), where the hydrogen and oxygen would either be compressed and packed into cylinders or be liquefied and packed into tanks.

Both the hydrogen and the oxygen produced by the electrolysis of water are valuable products and have potential applications in a variety of end uses.

As mentioned earlier, hydrogen is a unique, clean burning, renewable source of energy, and these particular properties have the potential to make hydrogen an important transport fuel of the future. Hydrogen also has applications as a reagent in various chemical processes.

Oxygen is also widely used in various industrial applications including chemical processes, combustion processes, aerobic fermentation, water purification and medical uses.

Another novel application for hydrogen and oxygen is that they can be utilised together in a fuel cell to produce electricity. For example, whereas an electrolysis cell applies an electric current to water to produce hydrogen and oxygen, a fuel cell operates in reverse and uses hydrogen and oxygen to produce an electric current.

Fuel cells convert chemical energy into electrical energy, and unlike batteries, which are only able to store electricity and can therefore run down, fuel cells will continue to operate at a constant power output as long as there is a continual supply of hydrogen and oxygen. Fuel cells therefore have potential for both transport and power generation applications, although the future use of fuel cells on a large scale will be dependent on having a readily available supply of cost effective hydrogen and oxygen.

By using a wind powered homopolar generator, the invention provides an efficient and cost effective method of directly producing the low voltage, high current needed to electrolyse water, which in turn helps to provide an efficient and economic water electrolysis process. Using renewable wind energy to power the homopolar generating system also ensures that the electric current supplied to the electrolysis unit will have been generated in a clean and pollution free manner.

Claims

1. A method of electrolysing water wherein the current required to effect the electrolysis is produced by a homopolar generator
2. A method as claimed in claim 1, wherein the homopolar generator comprises means to produce a toroidal magnetic field, means to position a conductive metal disc in the magnetic field, and means to collect the electric current generated in the conductive disc when the disc is rotated through the magnetic field
3 A method as claimed in claim 2, wherein the toroidal magnetic field is produced by either an annular magnet or more preferably an annular electromagnetic coil.
4 A method as claimed in claim 3, wherein the annular electromagnetic coil is manufactured from either conducting or more preferably superconducting material.
5. A method as claimed in claim 3 or 4, wherein the annular electromagnetic coil is surrounded by a core of highly permeable magnetic material such as soft iron
6. A method as claimed in any of claims 2 to 5, wherein the conductive disc is of a thin and substantially flat construction.
7. A method as claimed in claim 6, wherein the central and outer portions of the conductive disc are separated by a ring of insulating material.
8. A method as claimed in claim 6 or 7, wherein the conductive disc is spatially located so that the disc intersects both the forward and return magnetic fields of the toroidal magnetic field.
9. A method as claimed in claim 6, 7 or 8, wherein the conductive disc is connected centrally to a freely rotatable drive shaft so that the disc is also able to freely rotate about a central axis that is simultaneously perpendicular to the disc and coincident with the axis of rotational symmetry of the toroidal magnetic field.
10. A method as claimed in claim 9, wherein the conductive disc is connected to the drive shaft so that the disc is in close proximity to the electromagnetic coil producing the toroidal magnetic field.
11. A method as claimed in claim 9 or 10, wherein the application of a motive force to the drive shaft causes the conductive disc to rotate and intersect the toroidal magnetic field.

12 A method as claimed in claim 9, 10 or 11, wherein rotation of the conductive disc through the toroidal magnetic field causes electric charges to be generated in the central and outer portions of said disc.

13. A method as claimed in any of claims 2 to 12, wherein electrical contact brushes are located on a slide arm mechanism positioned above the surface of the conductive disc so that one brush is positioned over the central portion of the disc and another brush is positioned over the outer portion of the disc.

14. A method as claimed in claim 13, wherein the position of the brushes on the slide arm can be adjusted to and then fixed at the points of optimum current on the central and outer portions of the conductive disc respectively.

15. A method as claimed in claim 13 or 14, wherein another electrical contact brush is in contact with the drive shaft at the centre of the disc and yet another electrical contact brush is in contact with the outside rim of the conductive disc.

16. A method as claimed in claims 14 and 15, wherein the brush in the central portion of the disc is connected to the brush on the drive shaft, and the brush in the outer portion of the disc is connected to the brush on the rim of the disc.

17. A method as claimed in claim 16, wherein the two electrical circuits so formed are combined together either in series or in parallel, and the combined electric circuit has means to measure and control the current before it is supplied to a water electrolysis unit.

18. A method as claimed in claim 17, wherein the electricity from a single homopolar generator has a typical voltage of between about 1 and 2 volts and a current of about 5000 amps/m^2 or more.

19. A method as claimed in any preceding claim, wherein the homopolar generator is powered by wind energy.

20. A method as claimed in claim 19, wherein a concrete or steel mast supports a generator housing containing a multiplicity of homopolar generators combined together either in series and/or in parallel.

21. A method as claimed in claim 20, wherein said mast also supports a rotor wind blade arrangement that is coupled to a common drive shaft running through the homopolar generators

22 A method as claimed in claim 21, wherein rotation of the rotor wind blades by the force of wind rotates the drive shaft at a fixed, controlled speed

23. A method as claimed in claim 22, wherein rotation of the drive shaft produces an electric current in the multiple combination of homopolar generators and the combined current is fed to an electrical circuit that supplies the current to a multiple combination of water electrolysis units.

24 A method as claimed in any preceding claim, wherein the water electrolysis unit is a low pressure, low temperature electrolysis system that operates at about 70°C and under normal atmospheric pressure conditions, and where said water electrolysis unit consists of a large plurality of electrolysis cells each containing an electrolyte comprising a 25% solution of potassium hydroxide.

25. A system for supplying electric current to a water electrolysis process comprising wind powered homopolar generators producing a low voltage, high direct current, and an electric circuit to supply said electric current to low pressure, low temperature water electrolysis units.

26. A method of producing the low voltage, high direct electric current needed to electrolyse water into hydrogen and oxygen, whereby a homopolar generator powered by renewable wind energy is used to generate the required electric current.

27 A water electrolysis system comprising an electrolysis unit and a homoplanar electrical generator electrically coupled thereto.

28. A system as claimed in claim 27, wherein the homopolar generator comprises means to produce a toroidal magnetic field, means to position a conductive metal disc in the magnetic field, and means to collect the electric current generated in the conductive disc when the disc is rotated through the magnetic field

29. A system as claimed in claim 27 or 28, wherein the toroidal magnetic field is produced by either an annular magnet or more preferably an annular electromagnetic coil.

30. A system as claimed in claim 29, wherein the annular electromagnetic coil is manufactured from either conducting or more preferably superconducting material.

31. A system as claimed in claim 29 or 30, wherein the annular electromagnetic coil is surrounded by a core of highly permeable magnetic material such as soft iron.

32 A system as claimed in any of claims 28 to 31, wherein the conductive disc is of a thin and substantially flat construction.

33 A system as claimed in claim 32, wherein the central and outer portions of the conductive disc are separated by a ring of insulating material.

34 A system as claimed in claim 32 or 33, wherein the conductive disc is spatially located so that the disc intersects both the forward and return magnetic fields of the toroidal magnetic field.

35 A system as claimed in claim 33 or 34, wherein the conductive disc is connected centrally to a freely rotatable drive shaft so that the disc is also able to freely rotate about a central axis that is simultaneously perpendicular to the disc and coincident with the axis of rotational symmetry of the toroidal magnetic field.

36. A system as claimed in claim 35, wherein the conductive disc is connected to the drive shaft so that the disc is in close proximity to the electromagnetic coil producing the toroidal magnetic field.

37. A system as claimed in any of claims 28 to 36, wherein electrical contact brushes are located on a slide arm mechanism positioned above the surface of the conductive disc so that one brush is positioned over the central portion of the disc and another brush is positioned over the outer portion of the disc.

38. A system as claimed in claim 37, wherein the position of the brushes on the slide arm can be adjusted to and then fixed at the points of optimum current on the central and outer portions of the conductive disc respectively.

39 A system as claimed in claim 37 or 38, wherein another electrical contact brush is in contact with the drive shaft at the centre of the disc and yet another electrical contact brush is in contact with the outside rim of the conductive disc.

40. A system as claimed in claims 38 and 39, wherein the brush in the central portion of the disc is connected to the brush on the drive shaft, and the brush in the outer portion of the disc is connected to the brush on the rim of the disc.

41. A system as claimed in claim 40, wherein the two electrical circuits so formed are combined together either in series or in parallel, and the combined electric circuit has means to measure and control the current before it is supplied to a water electrolysis unit.

42. A system as claimed in claims 27 to 41, wherein the electricity from a single homopolar generator has a typical voltage of between about 1 and 2 volts and a current of about 5000 amps/m^2 or more

43 A system as claimed in any claims 27 to 42, wherein the homopolar generator is powered by wind energy.

44. A system as claimed in claim 43, wherein a concrete or steel mast supports a generator housing containing a multiplicity of homopolar generators combined together either in series and/or in parallel.

45 A system as claimed in claim 44, wherein said mast also supports a rotor wind blade arrangement that is coupled to a common drive shaft running through the homopolar generators.

46. A system as claimed in any of claims 27 to 45, wherein the water electrolysis unit is a low pressure, low temperature electrolysis system that operates at about 70°C and under normal atmospheric pressure conditions, and where said water electrolysis unit consists of a large plurality of electrolysis cells each containing an electrolyte comprising a 25% solution of potassium hydroxide.

The Patent Office

INVESTOR IN PEOPLE

Application No: GB 0308730.1
Claims searched: 1-24 & 27-46
Examiner: Pete Beddoe
Date of search: 3 March 2004

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1,27 at least	GB 2263734 A (PRITCHARD) see esp p3 lines 1-9, p7 line 6 - p9 line 20 & figs
X, E	1,27 at least	WO 03/083174 A2 (FERRIER) 9 October 2003 see esp p3 line 28 - p5 line 22 & figs
X	1,27 at least	US 4184084 (CREHORE) see esp col6 lines 28-51 & figs
X	1,27 at least	WO 02/084839 A2 (LAWSON-TANCRED) see esp p3 line 8 - p4 line 28 & figs
X	1,27 at least	WO 01/36817 A1 (LECTRIX) see esp p6 line 1 - p7 line 4 & fig 1
X	1,27 at least	JP 53-21088 A & WPI Accession no 78-27533A (KOBE) see esp figs & English abstract

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{W}:

C7B

Worldwide search of patent documents classified in the following areas of the IPC^{7}:

C25B

The following online and other databases have been used in the preparation of this search report:

Online: WPI, EPODOC, JAPIO